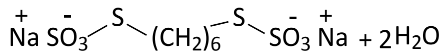
NOCIL LIMITED

PILCURE® DHTS

POST VULCANIZATION STABILIZER

Chemical Name	Hexamethylene-1, 6-bis(thiosulphate), disodium salt dihydrate (DHTS)	
Chemical Structure		
CAS Reg. No.	5719-73-3	
Mol. Wt.	390	
Product Specification		
Parameter	*Limits*	*Test Method*
Product form	Powder OT	-
Colour	White-Off white	-
Assay (Titration) ,% (min)	97.0	NOCIL 02-3-42
Moisture Content, %	8.5-10.0	NOCIL G-47
NaCl Content, % (Max)	0.5	NOCIL 02-3-42
pH (1.5% soln.), (min)	6.0	NOCIL G-42
Paraffinic Oil (<0.2% PCAH), %	1.0-2.0	NOCIL G-40
Residue on 53 µm sieve, % (max)	Nil	D 4570
Typical Data		
Specific gravity at 25°C	1.39	D 1817
Bulk density, kg/m^3	340-380	NOCIL G-44
Bulk density (Comp), kg/m^3	440-480	NOCIL G-44
Product Information		
Solubility	Soluble in water. Partially soluble in alcohol. Insoluble in other organic solvents.	
Classification	Post Vulcanization Stabilizer	
Discoloration & Staining	Non-staining and Non-discoloring.	
FDA Approval Status	Regulated for use in articles in contact with food under BgW XXI, Category 4. Not regulated for use in FDA food contact applications.	
Toxicity Data (Please refer to the latest Toxicological information.)	Practically non-harmful (Oral LD_{50} rat: over 5000 mg/kg). Not a skin or eye irritant but can cause allergic skin reaction.	
Handling & Personal Protection	In case of eye or skin contacts wash out with clean water for 5 to 10 minutes.	
Storage	Store at room temperature in closed containers and in a cool, dry and well ventilated place. Avoid exposure of the packaged material / product to direct sunlight & heat. Avoid extreme humid conditions and exposure to temperature above 40°C to prevent degradation.	
Packaging		
Paper Bag	20 kg	
FIBC	500 kg / 800 kg	
Storage Life	12 months when stored as stated above.	
Colour code	None	

COMPOUNDING INFORMATION:

a) PILCURE DHTS as a Reversion Resistant Chemical

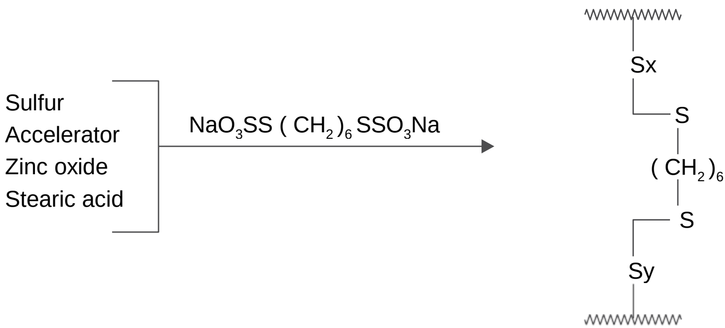
Ideally, during vulcanization of rubber, all available sulphur should be consumed in the formation of “Effective Cross Links” to join two polymer chains and transform the two dimensional polymer matrix into a three dimensional cross linked net work capable of bearing significantly higher stresses under static and dynamic conditions.

When Natural Rubber based sulfur cured compound is exposed to high temperature / over cure, significant changes in the physical properties are observed. These changes are related to modifications in the original cross link structure which occur during vulcanization. The main chain modifications (e.g. cyclic sulfides, pendant sulfides, and conjugated diene/ triene units) do not contribute to the elasticity of rubber vulcanizates and speed up the rate of degradation of the polymer chains. When the rubber compounds are over cured at high temperatures; the cross link density is drastically reduced, essentially mono sulfidic cross links are obtained, and there is a large increase in main chain modifications leading to reduction of physical properties

The thermal stability of cross links can be improved by using 1.5 - 3.0 phr of Pilcure DHTS.

Pilcure DHTS promotes the formation of flexible hybrid cross links within the sulphur cross link structure as follows:

Hybrid crosslinking mechanism of **PILCUPe® DHTS**



The sulphur chain length at the points of attachments to the polymer back bone is reduced and the thermal stability is improved. Maintaining a long chain within the cross link structure provides enhanced flexibility under dynamic conditions. In order to obtain the best performance with respect to the desired property, the dosages of sulfur, sulfenamide accelerator, stearic acid and Pilcure DHTS need optimization. Following table shows some starting point cure system recommendations.

PILCURE DHTS — Cure system recommendations for desired performance				
Performance Requirements	**Over cure protection**	**High temp. cure**	**Low heat build up**	**General purpose**
Sulphur, phr	2.2	1.0	1.3	1.1

Sulphenamide Accelerator, phr	1.6	2.3	1.1	1.0
Stearic Acid, phr	2.7	0.7	2.4	1.6
Pilcure DHTS, phr	1.8	1.6	3.0	2.8
Note: Pilcure DHTS is basic in nature hence dosage of stearic acid needs optimization.				

b) PILCURE DHTS as a Bonding Promoter for Brass Coated Steel Cord

It is established that polysulphidic cross links form a chemical bond with the copper subsulfide layer on the brass surface of the steel cord. In the presence of Pilcure DHTS in the steel cord rubberizing compound, hybrid cross links are formed in the vicinity of the rubber — metal interface. As these cross links have a lower number of sulphur atoms per link (Cu_RS to $(CH_2)_6$ group and / or $(CH_2)_6$ group to rubber), they show greater thermal stability than the polysulfide cross links. Also, on reversion of the NR based compound, there is less sulphur available to react further with the Copper - sub sulfide and Zinc oxide present at the brass surface and the bonds are more stable and the initial adhesion properties are not affected. While the number of sulphur atoms on each side of the $(CH_2)_6$ groups may be reduced to one on reversion, the remaining $(CH_2)_6$ group ensures greater flexibility in the Rubber — Brass bond as compared to the mono sulfidic cross links which are ultimately formed on reversion.

In the NR based steel cord rubberizing compound Cobalt or Nickel complexes are added to improve the stability of the adhesion bond in corrosive environments. Higher sulfur dosage (at least 4 phr) is used to ensure adequate adhesion strength so that a side reaction between Cobalt and sulphur can take place to produce cobalt sulfide. However, the presence of a pro-oxidant like Cobalt — salt produces a peptization effect in the compound during its storage causing viscosity variations in the stock. Higher sulphur dosages also affect the ageing performance of the tyre during service.

By using Pilcure DHTS based cure system it is possible to substitute the Cobalt / Nickel complexes from steel cord rubberizing compounds. When Pilcure DHTS is used, the side reaction between Cobalt and sulphur can be eliminated and it is possible to reduce the higher sulphur dosage. This improves the ageing performance of the compound during service and also eliminates the peptization effect imparted to the compound during storage by Cobalt-complexes.

When Pilcure DHTS based cure is used, it is necessary to use at least 1.0 phr Stearic acid for effective vulcanization. (Stearic acid dosages are lower when Cobalt complexes are used since the Cobalt complexes themselves contain fatty acid components.)

The recommended dosage of Pilcure DHTS for steel cord bonding promotion is 1.0 - 2.0 phr. Pilcure DHTS is more effective where corrosive environments such as steam & salt are involved.

Influence of PILCURE DHTS on Rubber Compounds:

Processing and Curing Properties:

Addition of Pilcure DHTS to a Conventional / Semi-EV cure systems tends to slightly reduce the Mooney Scorch Time and increase the Optimum Cure Time t'90 as determined during ODR test.

Reversion Resistance:

Optimized dosage of Pilcure DHTS gives significant improvements in ‘ Reversion Resistance ‘ due to the formation of more stable hybrid cross links.

Stress-Strain Properties:

The 300 % Modulus values show minor variation due to the formation of ‘hybrid cross links’. Pilcure DHTS at higher dosages (e.g. 3.0 phr) show significant improvement in Compression Set Resistance. There is no significant effect on Unaged Tensile Strength, Elongation at break, Hardness etc.

Flex - Fatigue Properties:

Addition of Pilcure DHTS significantly improves the Flex-Fatigue Life of Conventional and SemiEV cured Rubber Vulcanizates.

Thermal Oxidative Ageing of the Vulcanizates:

Addition of Pilcure DHTS does not affect the Oxidative Ageing properties of the Rubber Vulcanizates.

APPLICATIONS OF PILCURE DHTS:

DHTS is used at 1.0-3.0 dosage with Conventional or Semi EV sulphur cure systems to generate thermally stable hybrid cross links which provide excellent dynamic flexibility in NR, IR, SBR, BR and blends of these polymers.

DHTS is used at 1.0-2.0 phr dosage in SBR based tread compounds to modify its visco-elastic dynamic properties in order to improve the compromise between wet grip, ice grip and rolling resistance. DHTS is used at 1.0-2.0 phr dosage as an adhesion promoter to enhance the adhesion between rubber compounds and brass coated steel reinforcing materials such as steel cord.

Benefits offered by PILCURE DHTS:

- Vulcanization at High Temperature. (Shorter Cure Cycles & Increased productivity with least effect on the Physical properties of the vulcanizates.)
- Vulcanization over extended time. (Over Cure Protection.)
- Protection during Anaerobic Aging of Rubber Product during Service.
- Can be used with Conventional / Semi EV cure systems.
- The use of Pilcure DHTS eliminates the compromise between Thermal ageing and Dynamic Flex - Fatigue properties when high temperature cures or extended cure cycles are employed for highly unsaturated rubber based compounds.